Where is the destructive update problem?*

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Abstract I clarify the sense in which 'destructive update' of assignment functions is problematic for dynamic theories of anaphora. I argue that it is difficult to locate any problematic empirical predictions associated with destructive update. In a sense, this is unsurprising: destructive update of assignments is a characteristic feature of how binding is perpetrated in standard static systems (including first-order logic and the λ-calculus). I sketch a modular formal approach to the static/dynamic divide, arguing that dynamic systems with destructive update inherit their approach to assignments directly from static systems, but combine it with a view of assignments as information. I suggest that it's this constellation of formal properties, rather than destructive update per se, which is ultimately responsible for the intuition that destructive update is problematic.

1 Dynamic interpretation

In compositional dynamic reconstructions of DRT, sentences denote relations on assignments, type $s \to s \to t$ (e.g., Barwise 1987, Rooth 1987, Groenendijk & Stokhof 1991a, and Muskens 1996; Kamp 1981 and Kamp & Reyle 1993 are classic references on DRT). For example, sentence (1) is associated with the dynamic meaning in (2). This relation maps an input assignment g into a set of possible outputs, each associating the index 3 with a man who walked in the park (and otherwise just like g).[1]

(1) A man^3 walked in the park.

(2) $\lambda g.\{g^{3 \to x} \mid \mathsf{man}\, x \wedge \mathsf{witp}\, x\}$

The idea is that (2) models how (1) updates the value associated with the index 3 in context. Processing (1) means coming to associate 3 with a man who walked in the park.

The principal motivation for dynamic semantics is that indefinites can bind pronouns they don't scope over (i.e., c-command at LF). If (1) is continued with (3), it's possible and natural to hear the indefinite and the pronoun as covalued, though it's unlikely the indefinite could ever come to have scope over a pronoun in a separate sentence.

(3) He$_3$ whistled.

Dynamic semantics allows binding, even without scope. Dynamic sentence meanings store information about the values of variables in their output assignments. Dynamic conjunction, defined in (4), feeds the assignments output by a left conjunct as inputs to a right conjunct: the left conjunct outputs a set of potentially updated assignments

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1 The dynamic system used in this paper is a Montagovian refactoring of Groenendijk & Stokhof's (1991a) DPL.

$[\![L]\!]g$, which are fed one-by-one as inputs to the right conjunct, yielding new sets of potentially updated assignments, which are finally unioned to complete the update.

(4) $[\![L\,.\,R]\!] := \lambda g.\bigcup_{h\in[\![L]\!]g}[\![R]\!]h$

Dynamic conjunction guarantees that the right sentence in a conjunction is evaluated in the anaphoric context established by the left sentence. If (3) has the semantics in (5) (where 'g_3' names the individual g associates with the index 3), dynamically conjoining (2) and (5) yields (after a few simplifications) the meaning in (6), which covalues the walking man and the whistler, as desired. Binding transpires because the left conjunct outputs assignments that associate 3 with a man who walked in the park, which dynamic conjunction passes as inputs to the right conjunct.

(5) $\lambda g.\{g\}$ if $\mathsf{whistled}\,g_3$ else $\{\,\}$

(6) $\lambda g.\{g^{3\to x} \mid \mathsf{man}\,x \wedge \mathsf{witp}\,x \wedge \mathsf{whistled}\,x\}$

Truth conditions can be extracted from dynamic sentence meanings by existentially quantifying over outputs at a given input assignment, as in (7):

(7) K is True at $g \iff Kg \neq \{\,\}$

According to (7), (2) is True at an input g iff a man walked in the park; (5) is True at g iff g_3 whistled; and (6) is True at g iff a man who walked in the park whistled.

2 Destructive update

It is frequently suggested that the simplest dynamic systems — those identifying sentence meanings with relations on total assignments — have an undesirable feature: indices can be chosen in a way that allows information about the values of variables to be lost (see, e.g., Vermeulen 1993, 1995, Groenendijk, Stokhof & Veltman 1996, van Eijck 2000, 2001, Beaver 2002, Nouwen 2003, Brasoveanu 2007, Lebedeva 2012, Haug 2014, and Nouwen et al. 2016). This feature of dynamic theories goes by various names — e.g., the destructive update problem, the overwrite problem, or the downdate problem.

Consider (8). This text has two indefinites in separate sentences, bearing *the same index*. Given the obvious dynamic meanings for the individual sentences and the semantics for dynamic conjunction in (4), this text ends up associated with the interpretation in (9). The first indefinite updates 6 to be associated with some linguist who entered the room. The second tosses out the work of the first, reassigning 6 to a linguist who was already there. After the second sentence is processed, the entering linguist has been written out of the anaphoric picture: $(g^{6\to x})^{6\to y}$ is equivalent to $g^{6\to y}$, and so any subsequent pronouns will be unable to refer back to the first indefinite.

(8) A linguist^6 entered the room. A linguist^6 was already there.

(9) $\lambda g.\{(g^{6\to x})^{6\to y} \mid \mathsf{linguist}\,x \wedge \mathsf{entered}\,x \wedge \mathsf{linguist}\,y \wedge \mathsf{there}\,y\}$

A standard way of avoiding destructive update uses *partial* assignments to gauge whether an incoming assignment already harbors values for any indices a given sentence is looking to update. If so, some sort of non-default behavior is triggered — for instance, undefinedness, as in (10).[2] Proposals along these lines have been mooted by Dekker (1993), van den Berg (1996), Brasoveanu (2007), Nouwen (2007), Haug (2014), and others.

(10) $\lambda g : \neg\exists y.\,(6, y) \in g.\,\{g^{6\to y} \mid \mathsf{linguist}\,y \wedge \mathsf{there}\,y\}$

A related approach replaces assignments with sequences of individuals, updated via a monotonic operation like sequence extension, as in (11), where $\ulcorner s^\frown y \urcorner$ is the sequence s extended with the individual y. Proposals along these lines have been discussed by Vermeulen (1993, 1995), Dekker (1994), Groenendijk, Stokhof & Veltman (1996), Bittner (2001), van Eijck (2001), de Groote (2006), Nouwen (2007), Brasoveanu (2007), Charlow (2014), Bumford (2015), Nouwen et al. (2016), and others.

(11) $\lambda s.\,\{s^\frown y \mid \mathsf{linguist}\,y \wedge \mathsf{there}\,y\}$

Both kinds of proposals rule out destructive updates. Meanings like (10) force indefinites to be associated with *novel* indices, on pain of undefinedness. And meanings like (11) don't mention indices at all.

3 Truth conditions

Importantly, destructive update does not per se yield unacceptable truth conditions. Recalling our characterization of truth-at-an-assignment in (7), we observe that, at any input g, (9) returns an output iff (i) there's a linguist who entered the room, and (ii) there's a linguist who was already there. If (i) isn't met, then $\mathsf{linguist}\,x \wedge \mathsf{entered}\,x$ cannot be satisfied; if (ii) isn't met, then $\mathsf{linguist}\,y \wedge \mathsf{there}\,y$ fails. These are, as the reader can check, the same truth-conditions as we'd derive with contra-indexed indefinites — or, indeed, within a static generalized-quantifier theory. In particular, coindexing indefinites does *not* cause them to be covalued. This is a good result: texts like (8) systematically lack readings entailing that the two indefinite descriptions describe the same individual.

This isn't to say there could *never* be a theory where coindexed indefinites were covalued. Indeed, avoiding spurious covaluation is an important reason Heim's (1982) File Change Semantics requires indefinites' indices to be novel. A similar state of affairs is seen in DRT, where the construction algorithm for discourse representation structures must see to it that indefinites are associated with novel indices (Kamp & Reyle 1993: 84). There are also static theories that sometimes covalue coindexed indefinites: Reinhart's (1997) choice-functional theory covalues any two indefinites with the same descriptive content when they are interpreted via the same choice function (cf. Geurts 2000: 734).

The fact that the theories mentioned in the previous paragraph can, in principle, covalue multiple indefinites cannot, however, be blamed on destructive update. Indeed, in each of those theories, indefinites function as variables — i.e., as anaphoric: Heimian

2 $\ulcorner \lambda g : \phi.\,\psi \urcorner$ is the partial function f, such that $\mathrm{Dom}\,f = \{h \mid \phi[h/g]\}$, and for any $h \in \mathrm{Dom}\,f$, $f\,h = \psi[h/g]$.

indefinites are anaphoric to an existential closure operator; indefinites in DRT result in the construction of conditions anaphoric to a top-level discourse referent; and choice-functional indefinites are either anaphoric to an existential closure operator (Reinhart 1997, Heim 2011), or to a contextually provided choice function (Kratzer 1998). This anaphoric treatment of indefiniteness is the locus of problematic co-construal readings, which arise precisely when two indefinites are anaphoric in the same way. Indeed, having indefinites update assignments, destructively or otherwise, is something like the formal opposite of anaphora — updating assignments creates anaphoric possibilities instead of consuming them — and is thus an efficient way to *avoid* covaluation of indefinites.

4 Under-generation?

Are there any under-generation issues associated with destructive updates? Again, the answer seems to be negative. It is certainly true that after uttering *a linguist entered the room; a linguist was already there*, subsequent pronouns will be able, in principle, to refer back to either linguist — for example, in a sentence like *she greeted him*. It's also true that (9) doesn't allow this. The only linguist available after both sentences have been processed is the second one; the first has been dismissed from the conversational record.

However, under-generation is a property of *theories*: a theory under-generates iff it's inconsistent with some empirical observation. And while (8) and (9) don't make enough anaphoric possibilities available in conversational contexts where we seek to refer back to both linguists, it's nevertheless clear how theories with destructive update cope: they generate another parse, just like (8) but with contra-indexed indefinites.[3] Such a parse is consistent with the actual utterance, which has no overtly expressed indices.[4]

Another potential under-generation issue, discussed by Brasoveanu (2007: 113) and Haug (2014: 463), involves sentences with a single indefinite interpreted within the scope of a distributive conjunction, like the *and* ≫ *a donkey* reading of (12).

(12) Bill[1] and Sue[2] own a donkey[3]. (Muskens 1996: 181, ex. 66)

If proper names are interpreted as dynamic generalized quantifiers as in (13), and the conjoined subject is interpreted via generalized dynamic conjunction as in (14), only one donkey will be available for subsequent anaphoric reference (in this case, the donkey

3 In general, theories with destructive update generate strictly more interpretable parses in cases like (8) than theories which are unable to reuse indices on non-anaphoric expressions. Potential over-generation issues associated with destructive update are discussed in Section 5.

4 As two referees have pointed out, this analysis avoids under-generation by appealing to the syntax: for any utterance, the syntax generates a range of analyses compatible with its phonological form — here, analyses which assign different sequences of indices to the relevant constituents in a parse tree. This seems to be a relatively standard view of the division of labor between syntax and semantics, though I acknowledge that it is not universally shared (cf., e.g., Kamp & Reyle 1993, Jacobson 1999, and others). It bears emphasizing, however, that the argument here does not strictly depend on a syntactic view of indexation. For my purposes, it would do just as well to view the syntactic inputs to semantic interpretation as index-free, i.e., as under-specified (see, e.g., Poesio 1996 and especially Muskens 2011). Systems of this kind could, in principle, resolve under-specification post-syntactically in ways that generate destructive updates, or in ways that do not. It seems, then, that the theoretical locus of indices and indexation is orthogonal to the destructive update issue.

associated with Sue). The reason is similar to (8): (12) ends up equivalent to *Bill[1] owns a donkey[3], and Sue[2] owns a donkey[3]*, as in (15). The "second" occurrence of the indefinite erases the information contributed by the "first". Moreover, the contra-indexing trick that helped with (8) is no help here, since there is just one indefinite to play with (at least, absent literal syntactic conjunction reduction).[5]

(13) $[\![\text{Bill}^1]\!] = \lambda c.\lambda g.c\,\mathsf{b}\,g^{1\to\mathsf{b}}$ type: $(e \to s \to s \to t) \to s \to s \to t$

(14) $[\![\text{Bill}^1 \text{ and Sue}^2]\!] = \lambda c.[\![;]\!]([\![\text{Sue}^2]\!]c)([\![\text{Bill}^1]\!]c) = \lambda c.\lambda g.\bigcup_{h\in c\,\mathsf{b}\,g^{1\to\mathsf{b}}} c\,\mathsf{s}\,h^{2\to\mathsf{s}}$

(15) $\lambda g.\{(g^{1\to\mathsf{b},3\to x})^{2\to\mathsf{s},3\to y} \mid \mathsf{donkey}\,x \wedge \mathsf{owns}\,x\,\mathsf{b} \wedge \mathsf{donkey}\,y \wedge \mathsf{owns}\,y\,\mathsf{s}\}$

However, there are compelling reasons to pursue a different kind of analysis of such cases, one which does not inevitably write Bill's donkey out of the picture. Notably, a simple continuation like *it$_3$ brays* forces the wide-scope-indefinite reading of (12), on which there is a donkey that Bill and Sue own. There is no way to anaphorically target Bill's or Sue's individual donkeys on the wide-scope-*and* reading without making it clear which donkey we're interested in, for example with a locution like *in Bill's case, it$_3$ brays*.

These facts closely parallel what's observed with indefinites under quantifiers like *every linguist*. This suggests that, as is frequently done for indefinites under quantifiers, we should associate the indefinite in the relevant interpretation of (12) with a *parametrized* (i.e., functional) discourse referent, as in (16) (Krifka 1996; see van den Berg 1996, Nouwen 2003, Brasoveanu 2007, 2008, and Solomon 2011 for related ideas).[6] Here, the index 3 is mapped to a parametrized donkey D, 'intermediate' in a sense between Bill's and Sue's donkeys. Locutions like *in Bill's case* are one way to indicate how this parametric donkey is to be precisified.

(16) $\lambda g.\{g^{1\to\mathsf{b},2\to\mathsf{s},3\to\mathsf{D}} \mid \mathrm{Dom}\,\mathsf{D} = \{\mathsf{b},\mathsf{s}\} \wedge$
$\forall x \in \mathrm{Dom}\,\mathsf{D} : \exists y \in \mathsf{donkey} : \mathsf{owns}\,y\,x \wedge \mathsf{D}x = y\}$

Despite initial appearances, then, constructions like (12) don't present under-generation issues for dynamic theories with destructive update. Independently motivated analyses associate (12) with meanings like (16) rather than (15). And (16) harbors, in its own way, all the donkeys we could ever need.

5 Over-generation?

We might mount another sort of argument against destructive update. *A linguist entered the room; a linguist was already there* never has any readings that only serve up one of the two linguists for subsequent anaphora. That is, it just doesn't seem possible to interpret this text in a way that makes it impossible to refer back to the first-mentioned

5 Partializing the denotations of assignment-updating expressions in order to semantically enforce a novelty constraint, as in (10), does not solve this issue. In fact, it seems to leave us worse off: the prediction for such theories is that (12) is necessarily *undefined*. See Haug 2014 for pertinent discussion and a potential solution.

6 Though see Bumford 2015 for a contrary view. I leave it open how to understand the relationship between sentential conjunction and the conjunction that figures in distributive quantification, as in (12). This topic seems under-investigated.

linguist. Yet if destructive updates are allowed, the LF in (8) generates precisely such an interpretation. Isn't that an over-generation problem?

There is something to this argument. Yet it cuts so deeply, against so many kinds of theories, that caution is warranted. For one, this sort of 'over-generation' is seen in any theory that treats binding modularly — i.e., as the result of optional grammatical processes: if an operation necessary for binding applies optionally, it will always be possible to derive structures that 'erroneously' preclude *in principle* binding relationships that are possible — i.e., structures in which the operation necessary for binding has not applied. Such modularity is characteristic of a huge swath of theories, from static assignment-based systems like Büring (2005), to sequence-based dynamic theories like the one advocated in Charlow (2014), to systems that eschew assignment functions entirely, like the variable-free treatments of Jacobson (1999) and Barker & Shan (2014).

Moreover, even in static treatments of binding, it is possible to choose indices poorly, i.e., in ways that 'erroneously' rule out certain anaphoric relationships. Consider (17).

(17) Every linguist^{6} told every philosopher^{6} that she$_{6}$ read her$_{6}$ paper.

Here, two quantificational DPs bear the same index. Given standard assumptions about static interpretation (e.g., Heim & Kratzer 1998, Büring 2005), only one of these DPs can bind the downstairs pronouns. If, for example, *every linguist*^{6} c-commands *every philosopher*^{6} at LF, as the quantifiers churn through linguists x and philosophers y, the downstairs pronouns will be interpreted relative to doubly-shifted assignments $(g^{6\to x})^{6\to y}$. These assignments map 6 only to the philosopher y — the linguist x has been written out of the picture. As in the dynamic case, it is difficult to detect any such 'reading', one which positively prevents binding by both quantifiers.[7]

6 The static/dynamic divide

This is, of course, just to say that destructive assignment modification isn't the sole province of dynamic theories. The simplest static theories (e.g., Heim & Kratzer 1998, Büring 2005) allow assignments to be over-written as the interpretation function recursively descends the tree. Unlike dynamic theories, in static systems the overwritten assignment is used only in the service of calculating denotations for phrase markers (crucially, those with free prounouns). Once this happens, the modified assignment flickers out of existence. Modified assignments, in other words, are only passed *down* the tree, to constituents c-commanded by whatever modified the assignment in the first place.[8]

In dynamic theories, by contrast, modified assignments are retained as components of semantic values. They aren't just passed down the tree; they live on as an observable record tracing (aspects of) how a sentence came to be associated with its meaning.

It's illuminating to examine this point more formally. Consider Figure 1, an 'LF' for *John saw Mary*^{5}. This tree is cleaved into two parts: everything below ↑, and everything

7 In standard static theories, binding indices aren't borne directly by binders, but by abstraction nodes (e.g., Heim & Kratzer 1998, Büring 2005). This doesn't affect the point: coindexed abstraction nodes can still step on each others' toes. See Section 6 for a theory with indexed binders.

8 This is also, of course, how variable binding transpires in first-order logic and the λ-calculus.

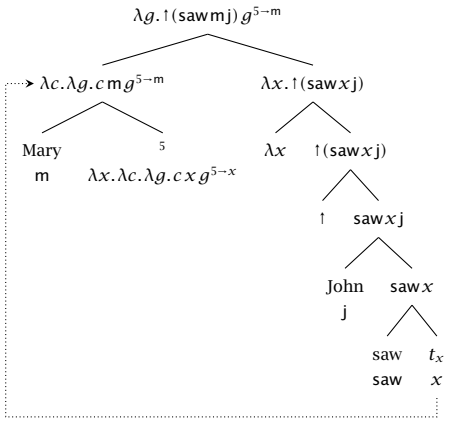

Figure 1: A modular perspective on static vs. dynamic semantics.

	Meaning for ↑	Result for Figure 1
Static	$\lambda p.\lambda g.p$	$\lambda g.\mathsf{sawmj}$
Dynamic	$\lambda p.\lambda g.\{g\}$ if p else $\{\ \}$	$\lambda g.\{g^{5\to\mathsf{m}}\}$ if sawmj else $\{\ \}$

Table 1: Ways to get static and dynamic sentence meanings out of Figure 1.

above it. The idea is to separate things that interact with assignments (binders and, eventually, pronouns) from things that don't. Below ↑, we have *John*, *saw*, and t_x.[9] Above ↑, we have (besides a λx binding the trace), the scoped-out, superscripted object *Mary*^{5}. Superscripting is treated categorematically: $\cdot^5$ turns *Mary* from a simple individual into a scope-taker that evaluates its scope relative to a shifted assignment — here, one mapping 5 to Mary (compare the dynamic entry for a proper name in (13)).

Doing functional application bottom-up yields $\lambda g.\uparrow(\mathsf{sawmj})\,g^{5\to\mathsf{m}}$ as the meaning of the sentence. What this amounts to turns on how we understand ↑. Two possibilities are given in Table 1. The first — treating ↑ as a function that takes a truth value and an assignment and returns the truth value — yields a *static* proposition, a function from assignments to truth values (in this case, since the sentence contains no unbound pronouns, a constant function from assignments to truth values). The second — treating ↑ as a function that takes a truth value and an assignment, and returns the assignment, conditional on the truth value — yields a *dynamic* proposition, a relation on assignments.[10]

9 N.B.: I intend Figure 1 as a logical form (that is, a semantic object) and not as a true LF. If this was a real LF, we'd of course have to say something about how the trace gets interpreted — perhaps something involving assignments! I am choosing (largely for expository simplicity) to theorize about pronominal binding separately from whatever ties a scoped-out expression to its trace. Similar dissociations between pronominal and trace binding are seen in Muskens 1996: 166–9, in Büring's (2005) distinction between β and μ operators, and indeed in any semantic approach to scope (e.g., Hendriks 1993, Barker & Shan 2014, Charlow 2014).

10 To obtain the continuized dynamic propositions of Dynamic Montague Grammar (e.g., Groenendijk & Stokhof 1990, Zimmermann 1991, Chierchia 1995, Szabolcsi 2003, de Groote 2006), set $[\![\uparrow]\!] \coloneqq \lambda p.\lambda g.\lambda k.\, p \wedge k\,g$.

Simple-minded as it is, this modular approach to statics vs. dynamics turns out to be pretty flexible. We are free to superscript and scope out the subject in addition to the object. Static and dynamic meanings for indefinites and quantified expressions integrate seamlessly, as well (with the notable consequence that the quantifier's *trace* is what bears the binding superscript; I leave the details of this as an exercise). More relevantly for present purposes, if we wish to bind an in-scope pronoun, as in constructions like *Polly^6 cited her$_6$ paper*, we can appeal to a lexical entry for pronominal expressions like (18) and a logical form like (19). With a static treatment of ↑, (19) returns $\lambda g.\,\mathsf{cited}\,(\mathsf{paper}\,\mathsf{p})\,\mathsf{p}$. With a dynamic-friendly ↑, (19) yields $\lambda g.\,\{g^{6\to \mathsf{p}}\}$ if $\mathsf{cited}\,(\mathsf{paper}\,\mathsf{p})\,\mathsf{p}$ else $\{\,\}$.

(18) $[\![\text{her}_6]\!] \coloneqq \lambda c.\lambda g.\,c\,g_6\,g$

(19) Polly^6 [λx [her$_6$ [λy [↑ [t_x cited t_y's paper]]]]]

From this point of view, then, the static/dynamic divide boils down to how we choose to think of ↑, the operator that builds a bridge between the parts of a sentence that care about assignment functions and the parts that do not.[11] This in turn casts the static vs. dynamic perspectives on destructive updates into sharp relief. Consider the logical form in (20), an analysis of *Polly^5 gave Anna^5 her$_5$ paper*. It has two superscripted proper names jockeying for a single index. This triggers a succession of assignment function updates; the first associates 5 with Polly, and the second re-associates 5 with Anna. The pronoun is evaluated against this doubly-shifted assignment, and thus ends up denoting Anna. We end up with the possibly static, possibly dynamic proposition in (21).

(20) Polly^5 [λx [Anna^5 [λy [her$_5$ [λz [↑ [t_x gave t_y t_z's paper]]]]]]]

(21) $\lambda g.\uparrow(\mathsf{gave}\,\mathsf{a}\,(\mathsf{paper}\,\mathsf{a})\,\mathsf{p})\,(g^{5\to \mathsf{p}})^{5\to \mathsf{a}}$

The key difference between the static and dynamic approaches to ↑ is what happens to the destructively updated assignment. With a static ↑, it vanishes entirely: (21) reduces to (22). With a dynamic ↑, it's retained as an output: (21) reduces to (23).

(22) $\lambda g.\,\mathsf{gave}\,\mathsf{a}\,(\mathsf{paper}\,\mathsf{a})\,\mathsf{p}$

(23) $\lambda g.\,\{(g^{5\to \mathsf{p}})^{5\to \mathsf{a}}\}$ if $\mathsf{gave}\,\mathsf{a}\,(\mathsf{paper}\,\mathsf{a})\,\mathsf{p}$ else $\{\,\}$

What this tells us is that the crucial difference between the static and dynamic perspectives on sentence meanings doesn't have much of anything to do with (destructive) assignment modification. As we move between the static and dynamic analyses of Figure 1, the treatment of assignment modification (i.e., superscripting) is invariant. In fact, the *only* thing that distinguishes the static analysis of Figure 1 from the dynamic one is

11 This division of labor (and of logical form) between different 'kinds' of meaning, mediated by an operator like ↑, is reminiscent of Karttunen's (1977) analysis of questions (with ↑ playing a role analogous to Karttunen's proto-question rule). It is also characteristic of *monadic* approaches to semantics (Shan 2002). In fact, the static ↑ in Table 1 is monadic, though the dynamic version isn't; a monadic, dynamic entry for ↑ is $\lambda p.\lambda g.\{(p, g)\}$. A properly monadic ↑ turns out to be important for turning the modular approach sketched in Figure 1 into a full-fledged grammar. As a bonus, monadic dynamic semantics immediately generates an account of exceptionally scoping indefinites (e.g., Fodor & Sag 1982, Reinhart 1997). See Charlow 2014, 2017 for discussion.

the way in which ↑ is understood. A static ↑ uses modified assignments to fix the denotations of bound pronouns, and then summarily tosses them out. A dynamic ↑ retains these modified assignments for future use.

7 Conclusion

So where is the problem of destructive update? One reasonable answer, by my lights, is 'nowhere'. Try as we might, we haven't been able to locate any problematic empirical predictions associated with it (a whiff of over-generation was shared by a wide range of static and dynamic theories, including ones that have nothing to do with assignments).

Another possibility, informed by the modular take on the static/dynamic divide just sketched, is that destructive update becomes a problem when combined with a dynamic ↑. Though our dynamic system inherits its approach to assignments and binding directly from our static system, the dynamic ↑ retains destructively updated assignments instead of discarding them on evaluation. On this reading, destructively updated assignments aren't problematic per se (I am not aware at present of any complaints lodged against 'the destructive update problem for static semantics'), but something about holding onto these assignments does harm.[12]

What is this something? Perhaps the most straightforward answer comes from the metasemantic gloss we tend to give to dynamic formalisms. Dynamic semantics, the story goes, models information growth; using a dynamic ↑ means treating assignment functions as information, as components of semantic values, and not as mere preconditions for returning semantic values. Information growth is a monotonic process — or, at the very least, any putative non-monotonicity is unlikely to be a consequence of our narrow semantic competence. Destructive update, however, is non-monotonic, and thus goes against the spirit of dynamic semantics. If we wish to use a dynamic ↑, we commit ourselves to treating assignments as information; if we then wish to update assignments, we should find a way to do so non-destructively (this is precisely what the approaches cited in Section 2 accomplish). This is a reasonable view, though the arguments for it seem to be philosophical or metasemantic, rather than properly linguistic.

Monotonicity is closely related to another formal property, *antisymmetry*: informally, an update system is antisymmetric if there's no way to turn back time — no way to undergo a series of (non-trivial) updates only to end up where you began. Though the dynamic systems considered in his paper aren't, strictly speaking, update systems (see Groenendijk & Stokhof 1991b: 60 for an update-theoretic recasting of the relational view of dynamics assumed here), their tolerance for destructive updates means they fail to be antisymmetric. We might begin with an assignment mapping n to x, overwrite n to point to some new value y, and finally overwrite n again to point to x, bringing us back where we started. Rothschild & Yalcin (2016, 2017) characterize what they call 'weakly static' systems, those representable by intersective (i.e., Stalnakerian (1978)) systems with context-sensitivity, as exactly those that are antisymmetric. The notion has a certain irony: in addition to violating intuitions about how a semantics that manipulates

12 Thanks to an anonymous referee for comments that helped me sharpen this point.

information should work, dynamic systems with destructive update are (other things being equal) more powerful than they need to be — truly dynamic, when weakly static would do.

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